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ANATOMICAL STUDIES ON *LOBOPHORA VARIEGATA* (PHAEOPHYCOTA) FROM THE COAST OF PAKISTAN

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Abstract

Lobophora variegata (Lamouroux) Womersley *ex* Oliveira [=*Dictyota variegata* Lamouroux], a fan-shaped, reddish brown alga of the family Dictyotaceae (Dictyotales, Dictyophyceae, Phaeophycota) was collected from Manora and Buleji, the coastal areas of Karachi (Pakistan) during March 2009 and February 2010. It was investigated in detail for its morphology, anatomy and reproduction. Surface cells of its thallus were studied in detail, where presence of dark coloured, horizontal or transverse lines were noticed on the thalli. During the study several new characters, such as very long cortical cells in the middle and basal portions of the thallus, horizontally elongated medullary cells which become almost cubical in the basal part, and the presence of induciate sporangia were observed.

Introduction

Lobophora variegata (Lamouroux 1809: 40) Womersley *ex* Oliveira 1977: 217 was reported for the first time from the coastal areas of Pakistan by Børgesen (1934). It is an intertidal brown alga (family Dictyotaceae, order Dictyotales, class Dictyophyceae, phylum Phaeophycota; *fide* Shameel, 2001, 2008), which grows on the mid to lower littoral rocks and rocky pools in the protected conditions (Shameel & Tanaka, 1992). It was taxonomically described from the coast of Karachi (Nizamuddin & Perveen, 1986; Begum, 2010) and reported to occur at the coast of Ras Malan, Balochistan (Shameel, 1987, 2000; Shameel & Afaq-Husain, 1987; Shameel *et al*., 2000). As no adequate information is procurable from the published literature on the anatomy of this species, the present study was planned to investigate in detail the external and internal structures and reproductive organs of this alga.

Materials and Methods

The specimens of *Lobophora variegata* were collected during March 2009 and February 2010 from mid-littoral rocks at Manora and Buleji, the coastal areas of Karachi Pakistan. The specimens were brought to the laboratory and preserved in 4 % formaldehyde-seawater solution after thorough washing. Some of them were used for herbarium preparations, which are deposited in the Herbarium (FUU-SWH), Department of Botany, Federal Urdu University of Arts, Science and Technology, Karachi. Rest of the specimens were used for general study, where cross sections (C. S.) of the algal material were obtained free hand with the help of shaving blades, stained in aniline blue and mounted in glycerine. The slides were sealed with nail polish and examined under a Nikon PFX microscope, the seaweed sections were photographed with the help of a Nikon F601 camera.

Results and Discussion

The following taxonomic characters and anatomical features were observed on general investigation and microscopic examination of the collected specimens.

***Lobophora variegata* (Lamouroux) Womersley *ex* Oliveira 1977: 217**

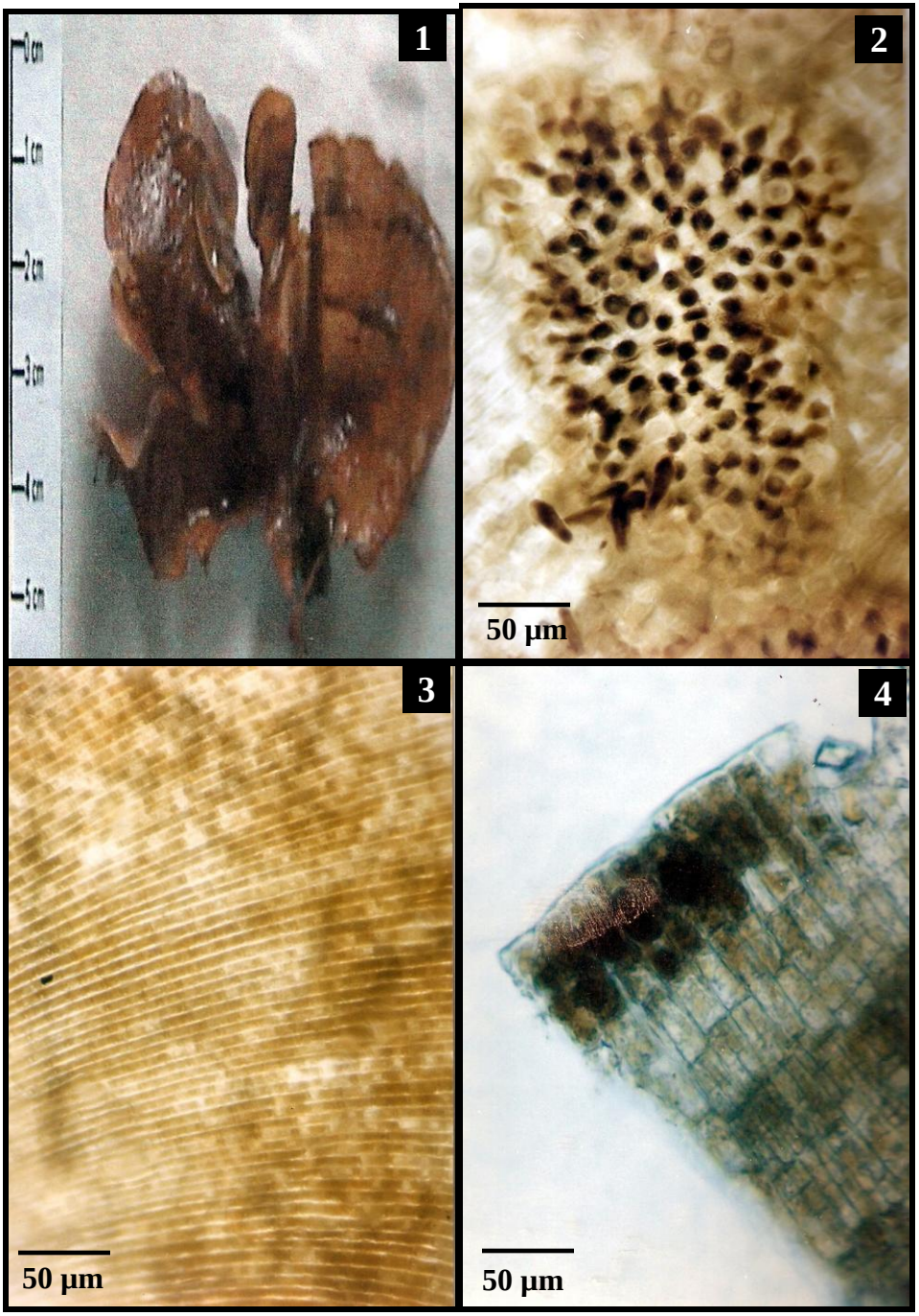
Basionym: *Dictyota variegata* Lamouroux 1809: 40.

Synonyms: *Zonaria variegata* (Lamouroux) C. Agardh 1817: 20, *Pocockiella variegata* (Lamouroux) Papenfuss 1943: 463, *Lobophora variegata* (Lamouroux) Womersley 1967: 221.

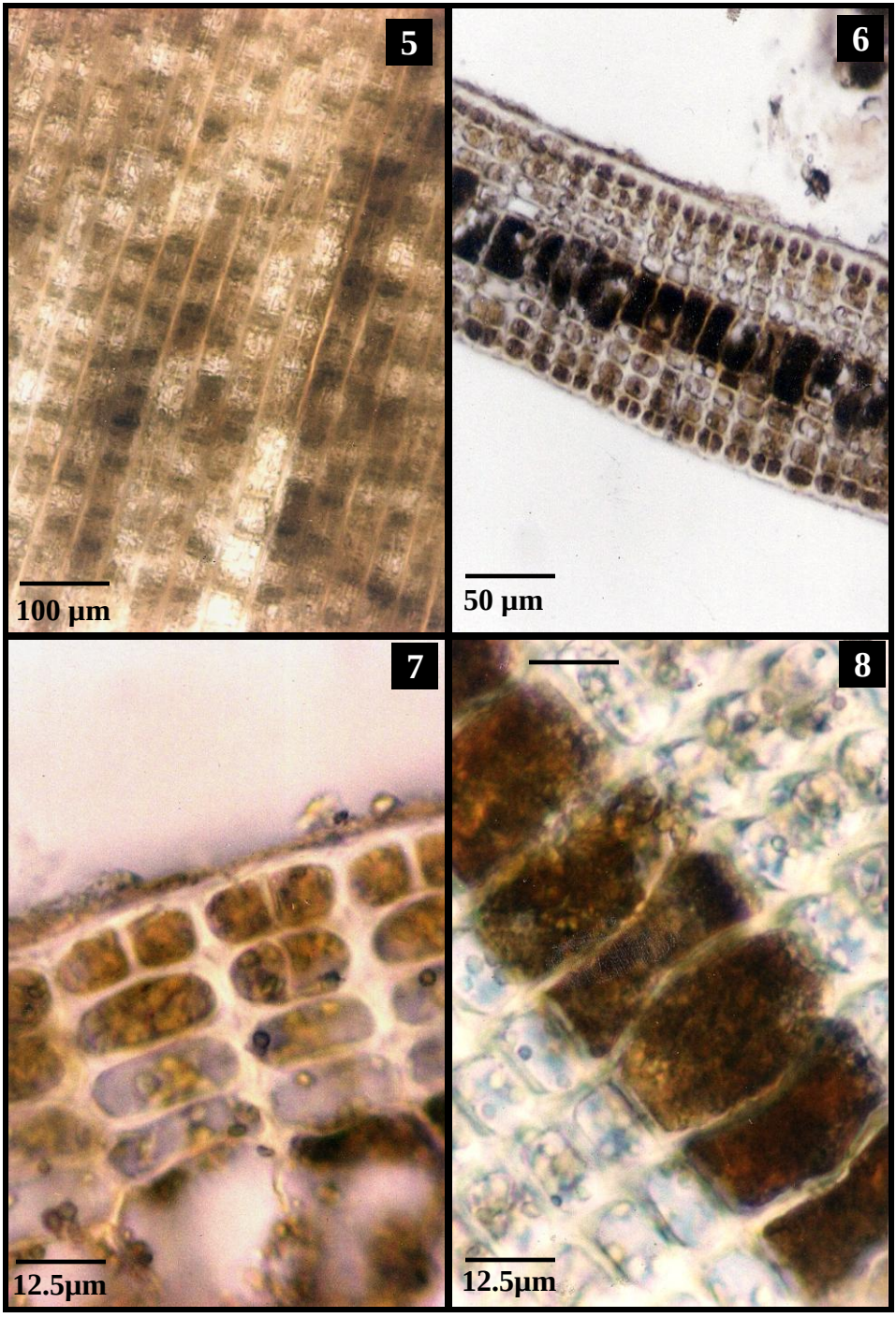
References: Børgesen, 1934: 28; Durairatnam, 1961: 34; Misra, 1966: 164; Womersley, 1967: 221, 1987: 253; Krishnamurthy & Joshi, 1970: 11; Islam, 1976: 38; Jaasund, 1976: 43; Allender & Kraft, 1983: 81; Nizamuddin & Perveen, 1986: 131; Shameel, 1987: 513, 2000: 51; Shameel & Afaq-Husain, 1987: 295; Silva *et al*., 1987: 77, 1996 : 598; Shameel & Tanaka, 1992: 38; Shameel *et al*., 2000: 84; Begum, 2010.

Morphological characters: Thalli erect, dark brown or reddish brown, mature thalli fan-shaped, margins undulate and slightly curved, lobes not present (Fig. 1); apex slightly undulate, complete; attenuated base, surface smooth; concentric rows of sporangia present in sori from apex to the middle (Fig. 2); on the basal surface sporangial sori irregularly distributed on both surfaces, large number of sori present on the ventral surface and only a few of them present on the dorsal surface; thallus attached with the help of a small, compact, solid holdfast, 3–6 mm long and 2–4 mm broad; thalli 3–6 cm long, 3–4 cm broad at the apex, 4–5 cm broad at the middle and 1.0–1.5 cm broad at the base. One part of thallus looks like rose petals or rosette shaped; reproductive organs or sporangial sori present on both surfaces of the thallus; thalli feel hard to touch, leathery, lower portion dark coloured as compared to upper portion; dark coloured transverse and horizontal lines present on the surface of the thalli (Fig. 3); growth by an extensive marginal row of apical cells (Fig. 4); surface cells larger than breadth, rectangular, 7.5–20.0 µm in length and 7.5–10.0 µm in breadth (Fig. 5).

Anatomical features: In the apical portion: thallus consists of 8–9 layers, upper and lower peripheral layers and 2–3 layered cortex on both sides of medulla, and single layered medulla present at the center (Fig. 6). Peripheral cells small, cubical or slightly rounded, thin walled, a small gap present between peripheral cells, dark brown with dense phaeoplasts, 12.5–15.0 µm in length and 7.5–10.0 µm in breadth; 2–3 layered cortex on both sides of medulla, cortical cells, large, vertically elongated, thin walled, inter-cellular spaces present, corners or edges of cells slightly rounded, poor in content, but some parts contain dense phaeoplasts, arranged in regular tires, 20–25 µm in length and 10.0–12.5 µm in breadth (Fig. 7); single layered medulla consists of large, horizontally elongated or palisade-like, thick-walled cells, dark brown in colour with dense phaeoplasts, cells are variable in size, some cells are broader than others (Fig. 8), intercellular spaces absent, some cells have oil globules (Fig. 9), 25.0– 42.5 µm in length and 10–25 µm in breadth.



Figs. 1-4. *Lobophora variegata*: 1. Habit of the thallus, 2. Surface view with sporangial sori, 3. Surface view with dark coloured lines, 4. Surface view with marginal row of apical cells.



Figs. 5-8. *Lobophora variegata*: 5. Surface cells, 6. C.S. of apical portion of thallus, 7. Peripheral cells and cortex in apical part, 8. Medullary cells in apical portion.

In middle part: thallus consists of 8–9 layers; upper and lower peripheral layers enclosing 2–3 layered cortex present on both sides of single layered medulla (Fig. 10). Peripheral cells small, thin-walled, cubical or rounded, dark coloured with dense phaeoplasts, 10–15 µm in length and 7.5–10.0 µm in breadth; 2–3 layered cortex consists of vertically elongated, thin-walled cells, poor in contents, intercellular spaces present, edges of cells slightly rounded, 20.0–32.5 µm in length and 10–15 µm in breadth; single layered medulla consists of large cells, slightly elongated or cubical, thin-walled, with or without phaeoplasts, intercellular spaces absent, 20.0–30.5 µm in length and 20–30 µm in breadth.

In the basal portion: thallus consists of 9 layers (Fig. 11); peripheral cells forming prominent lines in surface view, small, cubical or slightly rounded, thin-walled, dark brown with dense phaeoplasts, 10.0–12.5 µm in length and 10–15 µm in breadth; 3 layered cortex present on both sides of medulla, cortical cells, vertically elongated (Fig. 12), thick-walled, intercellular spaces present, poor in contents, but sub-epidermal layer contains dense phaeoplasts, 25–50 µm in length and 10–15 µm in breadth; single layered medulla present in the center, medullary cells large, cubical or horizontally elongated or quadratic, dark coloured with dense phaeoplasts or poor in contents, 25–45 µm in length and 17.5–32.5 µm in breadth; cell-wall thickness 2.5–5.0 µm (Fig. 13).

Reproductive structures: Sporangia present in a sorus, covered with inducium (Fig. 14), arising from epidermal cells (Fig. 15), sporangia cylindrical or balloon-like, dark brown in colour, 10–25 µm in length and 7.5–50.0 µm in breadth (Fig. 16).

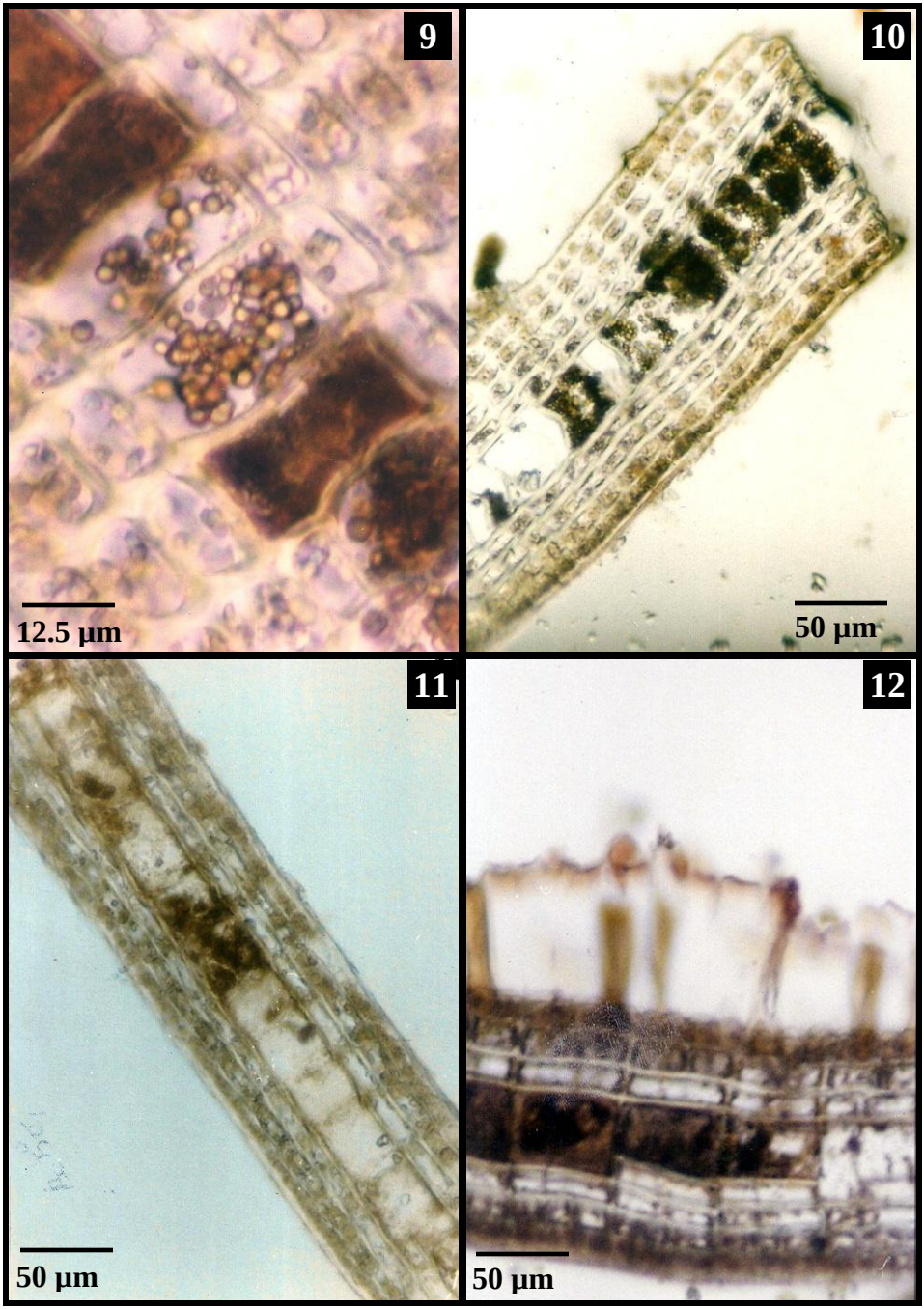
Habitat: Collected as drift material at Manora (*Leg*. Alia Abbas 6-4-2009); Buleji (*Leg.* Alia Abbas 31-3-2009, 12-2-2010).

Type locality: Antilles, West Indies.

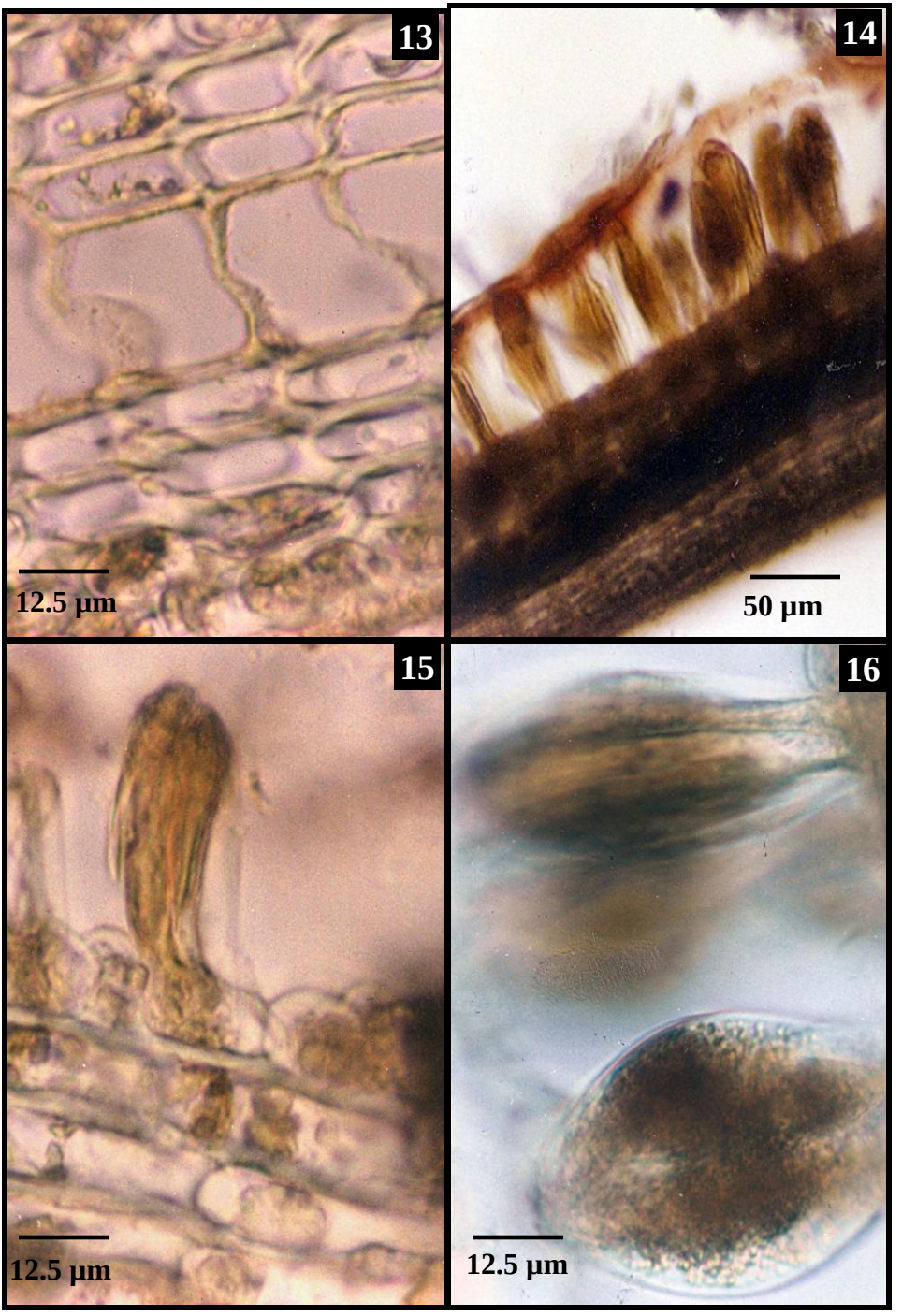
Local distribution: Karachi: Manora, Buleji and Cape Monze; Balochistan: Ras Malan.

Distribution around Arabian Sea: Bahrain, India, Iran, Laccadive Islands, Maldives, Oman, Pakistan, Saudi Arabia, Somalia and Sri Lanka.

Remarks: Womersley (1967) did not cite the basionym, while attempting to make the combination *Lobophora variegata*. It became *nom. inval.,* as this attempt failed to satisfy Art. 33. 2 of ICBN (Silva *et al*., 1996). Later on the combination was validly published by Oliveira (1997). It is a fan shaped, reddish brown alga (family Dictyotaceae, order Dictyotales, class Dictyophyceae, phylum Phaeophycota; *fide* Shameel, 2001, 2008), and grows in the mid to lower littoral region of the Karachi Coast of Pakistan. As observed in the present specimens, the presence of black coloured, horizontal or transverse lines were not described before by previous workers (Børgesen, 1934; Duraitnam, 1961; Misra, 1966; Womersley, 1967; Jaasund, 1976; Nizamuddin & Perveen, 1986). Similarly, several new characters such as very long cortical cells in the middle and basal portions of the thallus, horizontally elongated medullary cells which become almost cubical in the basal part and the presence of induciate sporangia were observed during this study, and surface cells of the thallus were investigated in detail. All these observations were not made previously.



Figs. 9-12. *Lobophora variegata*: 9. Oil globules in medullary cells, 10. C.S. of middle portion of thallus, 11. C.S. of basal part of thallus, 12. Elongated cortical cells in the basal portion.



Figs. 13-16. *Lobophora variegata*: 13. Medullary cells in basal portion, 14. Sporangia covered by inducium, 15. Sporangium arising from a peripheral cell, 16. Two sporangia.

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